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ABSTRACT

Relationships between variables representing substantive, semantic, and strategy elements of teacher behavior during concept instruction and class residual gain scores on a test of concept learning were examined as twenty-two teachers instructed groups of fifteen third, fourth, and fifth grade pupils in two forty-five minute lessons on the social science concept, specialization. Significant low-inference behaviors included giving concept definitions and positive examples, reviewing within lessons, including more of the relevant generalizations and concept labels. Significant rated variables included accuracy of definitions and examples, relevance of behavior to objectives, balance of concrete-abstract terminology, and enthusiasm. (Author)

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TEACHER BEHAVIORS RELATED TO STUDENT ACHIEVEMENT ON A SOCIAL SCIENCE CONCEPT TEST

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(A paper presented at the Annual American Educational Research Association Meeting, San Francisco, California, April 20, 1976)

A basic assumption underlying performance-based teacher education programs is that there are identifiable, operationally-defined behaviors which can be taught, learned, and used in actual classrooms. It is further assumed that these behaviors relate to desired pupil outcomes (Okey, 1974). A weak empirical base presently supports these assumptions (Heath and Nielson, 1974).

Process-product investigations have surfaced a number of high-inference teacher variables which consistently relate to student achievement scores. The oft-quoted research summaries of Rosenshine and Furst (1971) and Rosenshine (1971) point to

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[1] This study was conducted in Bloomington, Indiana, during the Spring of 1975.

such promising variables as clarity, variability, enthusiasm, task orientation, student opportunity to learn the criterion material, and the use of student ideas. Although the names of these variables continually reappear in the literature, it is difficult to draw comparisons across studies due to differences in the defining of the variables, and in the conception, design and methodology of the various investigations.

Most of the research into teacher behavior to date has been correlational . . . certainly not sufficient for drawing inferences of a cause-effect nature. Even beyond the already-mentioned problems, the state of the art of correlational process-product research leaves much to be desired. Few studies attempt to relate particular counted units of observable, overt teacher behavior to the subjective ratings of perceived behavior. Thus, the low inference correlates of such promising high inference behaviors as clarity are still unknown.

Further, it may be hypothesized that there is a relationship between <u>what</u> is being taught and the most productive teacher behaviors. Investigations are needed which attempt to identify relationships between instructional intent, teacher behaviors, and student achievement of the specified objectives.

The study which is reported here is an attempt to explore such relationships. The basic problem of this exploratory investigation was to determine what relationships exist between select teacher verbal behaviors occurring during social science concept instruction and the residual class mean gain scores of third, fourth, and fifth grade students on a test of the social

science concept specialization. Teacher and student process behaviors occurred during two forty-five minutes subject-matter controlled lessons, conducted in a discussion mode to randomly selected class halves.

The focus of this study was upon the teacher's behavior during concept instruction. This behavior is of particular interest due to the emphasis upon concept learning as a major goal in new curricular programs in the social sciences. Underlying the inclusion of social science concepts in instructional programs are at least two basic assumptions: (a) that social science concepts will be interesting and meaningful for students, and (b) that teachers will present them effectively (Davison, 1971). While many models exist for structuring concept learning (Martorella, 1971), there is little evidence suggesting which particular teacher behaviors relate most consistently to pupil achievement on concept tests.

Teacher process variables examined in this study were derived from two sources: (a) process-product correlational research, and (b) concept learning experimental investigations. A particular effort was made to select behaviors which were likely to occur during concept instruction.

Method

Subjects.[2] The sample of teachers was drawn from fifty-five

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[2] Sincere appreciation is extended to the children, teachers, and administrators of the Monroe County Schools, Bloomington, Indiana, who participated in this study.

undergraduate seniors enrolled in a field-based, two semester program for Elementary Education majors at Indiana University. The population was to be all pre-service teachers assigned to third, fourth, and fifth grade classes in three participating schools. During the Spring, 1975, semester, this totalled twenty-seven persons. Two classroom teachers declined to have their classes participate in the study, essentially because of scheduling difficulties. This eliminated four pre-service teachers from the study (in many instances, two pre-service teachers were assigned to one classroom). One pre-service teacher requested to be released from participation due to personal problems. Thus, twenty-two pre-service teachers (twenty-one women, one man) actually participated. In addition, two experienced classroom teachers volunteered to be subjects (one woman, one man, both fifth year teachers).

Due to technical problems associated with the audio taping of lessons, data were lost from two subjects. Thus, twenty-two subjects (hereafter known as teachers) were able to submit fully admissible data; this group included twenty pre-service teachers (nineteen women, one man) and the two experienced teachers. Eight teachers instructed groups of third grade students; four teachers instructed fourth grade classes; and ten teachers instructed fifth grade groups.

Children within intact classrooms were randomly divided (using a table of random numbers) by the investigator into two groups, each group numbering approximately fifteen students. In most of the participating classrooms, there were also two

participating teachers. Each class half was randomly assigned to each teacher by the investigator.

Admissibility of student data was determined by the student's participation in four events: pretesting, two instructional sessions, and one posttesting session. A total of three hundred twelve children participated.

Certainly it is important to note the obvious - research in actual classrooms has its limitations. Efforts to randomize the selection of students and teachers often falter because of administrative, technical complications. To the extent that this study fails to meet the requirements for randomization in the selection of pupils and teachers, the ability to generalize from the results to other groups is hindered.

Focus of Instruction. The economic concept specialization was selected as the focus of instruction. Pedagogically, it was important to select a concept which was a legitimate idea in its own right and which would be viewed by students and teachers as worthy of investigation. A survey of social science curricular materials for grades 3-5 was conducted to aid in the identification of a reasonable concept-focus.

One week prior to the onset of the pretesting of students, each teacher was provided with an Instructions for Teachers manual. Included were specific instructional objectives for the two lessons on specialization and background substantive information on the concept of specialization. The instructional objectives called for the student to be able to identify examples and

non-examples of the concept, specialization, in its three forms - occupational, technological, and geographical; to relate specialization to the concepts of interdependence and trade; and to be able to identify examples of the problems associated with specialization.

The background substantive knowledge included in the manual provided the teacher with concept definitions and examples, along with generalizing statements explaining the nature of specialization.

Procedure. Two weeks prior to the pretesting of students, the teachers met with the investigator for an orientation session. While a general explanation of the study was provided, no mention was made of the particular categories of teacher behavior which were of interest to the investigation. One week before pretesting, teachers received a list of the randomly-selected children in the class who constituted the instructional group. Also, the Instructions for Teachers manual was distributed and discussed at this time. Teachers were cognizant of the fact that students would be tested on items constructed to be congruent with the instructional objectives. The teachers at no time were aware of the actual test items.

Four five-day research sequences were identified, extending over a two week period. Each sequence consisted of five parts: (a) pretesting; (b) "resting" for two days; (c) conducting the first concept lesson; (d) conducting the second concept lesson; and (e) posttesting.

Pre- and posttesting sessions were conducted by the investigator and/or trained assistants, with all teachers absent from the classroom. Each student had a copy of the test items and an answer form; each item was read aloud by the test administrator to minimize the interference of irrelevant reading problems.

On each of the consecutive fourth and fifth days of the research sequence, each teacher conducted a forty-five minute lesson on specialization with the randomly assigned class group. Instruction was to be conducted primarily in a discussion mode and was to occur in a geographically distant setting from the remaining class half. Lessons were audio-taped by the teacher. Class groups were posttested by the investigator within one hour following the end of the second lesson.

Instrumentation, Criterion Measure. The statistical unit of analysis representing teacher effectiveness of concept instruction was the residual class gain score obtained on the Student Test of Understanding of the Economic Concept, Specialization (STUEC,S). STUEC,S was a thirty-eight item, true-false test developed by the investigator to measure student attainment of the instructional objectives.

A pilot study was conducted during the winter of 1974-75, to collect samples of teacher behavior and to assess the difficulty levels of STUEC,S items and the ability of the items to discriminate between groups receiving instruction in specialization and uninstructed groups. Items were refined on the basis

of this knowledge.

Content validation by a panel of economic educators, concept-learning educators, and elementary social studies educators supported the contention that the test items were congruent with the instructional objectives and with economic knowledge. The Spearman-Brown reliability coefficient for combined third, fourth, and fifth grade classes on the posttest was .76.

Instrumentation, Teacher Process Variables. Teacher process variables represented aspects of the substantive, semantic, and strategic characteristics of a concept instructional event. The selected variables were essentially cognitive in nature and were derived from process-product investigations and from experimental studies of concept learning. (A complete list of teacher and student process variables can be found in the Appendix attached to this paper.)

Three instruments were developed by the investigator to operationally define the process variables under examination. (a) A rating form was utilized for the recording of the high inference variables: accuracy of concept definitions, accuracy of concept examples, relevance of teacher utterances to the instructional objectives, balance of concrete-abstract terminology, uses complete sentences, displays interest and enthusiasm over the content of the lesson, and on-task behavior. These variables were rated by the trained observer on a one-to-seven continuum.

(b) A Tally Sheet was developed to record the low inference

variables, adequacy of knowledge coverage and adequacy of concept label coverage. From the set of instructional objectives, the investigator derived fifteen knowledge components, or generalizations, which encompassed the essential information required to know the meaning of the concept and to fulfill the tasks implied by the instructional objectives. A list of nine concept labels, or names, was also derived from the instructional objectives. The trained observer listened to the audio-tape recorded lessons for verbal indications of the teacher's explicit inclusion of each of the knowledge components and each of the concept labels.

(c) An Observational System for Concept Instruction (OSCI) was developed to record the pattern and frequency of the low inference teacher strategic behaviors and the student process behaviors. (Select student behaviors were examined in the original investigation, but are not being reported in this paper.) The unit of teacher behavior which was counted was the purposive move. A purposive move referred to an activity performed by the teacher which had the apparent function or effect of progressing the lesson from one substantive or process point to another. Each purposive move was a statement or question which expressed a more or less complete idea and served a single function, as defined by the eleven categories of the observational system.

The investigator and a trained assistant coded the audio-taped lessons. Three eight-hour training sessions were conducted

before the criterion reliability level of 0.80 of observer agreement was achieved for each of the three instruments utilized in the study. Levels of agreement between observer one and observer two at the end of the training period, utilizing Scott's Index of intercoder agreement formula were $\pi = 0.92$ for each of two independently coded audio-taped lessons of forty-five minutes each.

Half-way through the data coding period, another reliability check was made. Scott's coefficient of reliability between observers was $\pi = 0.90$. Scott's coefficient of reliability for observer one's agreement with self over time was $\pi = 0.83$; for observer two, $\pi = 0.86$. Thus, it can be said that the observers maintained an acceptable level of agreement with each other and with themselves over the course of the data coding procedure.

The set of audio-tapes was stratified along grade levels and then randomly assigned to the two observers. Each observer applied the OSCI to the lessons of eleven teachers and applied the Tally and Rating forms to the lessons of the other eleven teachers. Scores for all variables were averaged over the two lessons for each teacher.

Analysis. For the purpose of this research, the criterion measure was the residual classroom mean gain score on the Student Test of Understanding of the Economic Concept, Specialization. The criterion measure was defined by computing the regression of pretest score on posttest score within each classroom. The

difference between actual and estimated posttest scores were then aggregated over the classroom. Table 1 presents the class raw means on pre- and posttests and the residual gain scores.

INSERT TABLE 1 HERE

Pearson product moment correlation coefficients determined the strength of the relationships between teacher process variables and student achievement.

Results

One question asked in this investigation was: What relationships exist among high inference and low inference teacher process variables?

INSERT TABLES 2 AND 3 HERE

The high inference variable, relevance of the teacher's utterances to the instructional objectives, could be expected to relate to low inference task-oriented variables. As seen in Table 3, positive correlations (r = .23, .25, and .26 respectively) relate relevance with the following strategic variables: the teacher gives a concept definition, asks for a concept definition, and the total frequency of definition-related behaviors. Stronger, significant relationships occur between relevance and concept-example behaviors: the teacher gives a positive concept example (r = .50); the teacher asks students

to give a positive concept example (r = .46); and the total frequency of all example-related behaviors (r = .53).

Other strong low inference correlates of relevance include: the teacher reviews, summarizes the main ideas in the lesson (r = .52); teacher answers own or student's question by explaining (r = .45); and the teacher asks a high order question (r = .40). Thus, during concept instruction, the tendency of the teacher to engage in the giving of and asking for positive concept examples, the reviewing of main ideas, the answering of substantive questions, and the asking of high order questions is related to the high rating of the teacher on the variable, relevance of behavior to the instructional objectives.

The validity of the relevance rating is further enhanced by an examination of some of the negative correlates: giving off-task information (r = -.57); digressing substantively (r = -.10); and repeating a question after student response (r = -.18).

Let us also examine the strategic-move correlates of the low inference variables, <u>adequacy</u> of content and concept label coverage. The low inference strategic variables and the low inference adequacy variables were counted by <u>different</u> observers. The <u>adequacy</u> variables dealt with the completeness of the knowledge made explicitly known to students during the lessons. Significant positive correlates of the adequacy of content coverage and adequacy of concept label coverage variables, respectively, include:

the teacher . . .

- gives a concept definition (r = .43, .63);

•asks for a concept definition (r = .46, .63);

•totals, definition-related behavior (r = .49, .69);

•gives a positive concept example (r = .56, .47);

•asks for a positive concept example (r = .52, .39);

•totals, example-related behavior (r = .60, .50);

•reviews, summarizes the main ideas (r = .62, .54); and

•answers question, explains (r = .48, .37).

These strategic moves appear to be quite obvious methods by which teachers traditionally convey or elicit the "content" or knowledge implied by the instructional objectives, especially during a concept learning event.

In general, Table 3 shows that variables which logically relate to one another are empirically linked also. (A further example: the on-task rating correlates negatively with off-task counted behaviors, r = -.71). For some of the rated variables, the specific teacher-move correlates provide insight into the nature of the variable.

The major question of this study was:

•What relationships exist between teacher process variables and the residual class gain score?

INSERT TABLE 4 HERE

Five low inference teacher process variables (and two combinations of variables) relate significantly, and in a positive direction, with the criterion measure. These behaviors

are: the teacher gives a concept definition, gives positive concept examples, reviews the main ideas, explicitly includes more of the implied generalizations (covers the content), and includes more of the concept labels. In addition, the total frequencies of definition (giving and asking) behavior and the total of example behavior (giving and asking, positive and negative examples) are also related strongly with student gain (Table 4). A discussion of each follows.

(1) Defining the concept. All concepts have attributes and rules for defining the relationships among the attributes. A concept definition calls attention to the concept's relevant characteristics. The teacher behavior, gives a concept definition, implies an expository, task-oriented approach, in which the teacher makes known to students the relevant concept dimensions. The variable, the teacher asks students to give a concept definition, is a positive, but not strong, correlate of student achievement. The results of experimental investigations exploring task variables during concept attainment generally support this finding. Pointing out the critical properties, or the conceptual rule, tends to increase the ease of concept attainment more than permitting the subject to discover the rules (Clark, 1971).

(2) Exemplifying the concept. The teacher behavior, gives positive concept examples, is a strong correlate of student gain. This behavior is also supported by experimental studies which generally find that the greater the proportion of positive instances, the easier the concept attainment (Clark, 1971). The relationships between the giving and asking of negative concept

examples and student gain cannot be fully explored in this study due to their low frequency of occurrence. No teacher asked students to provide a non-example of specialization. The positive relationship of the giving of negative concept examples with student gain suggests the worthiness of further investigation into the strength of this variable.

(3) Reviewing the main ideas. The summarizing, restating, or rephrasing of the main points in a lesson is shown to be a strong correlate of achievement. The strength of the use of review has been pointed out by previous process-product investigators (Fortune, 1967; Wright and Nuthall, 1970).

(4) "Covering the content". The adequacy of the substantive aspect of instruction variable is defined as the number of explicit statements made by the teacher of generalizations implied by the instructional objectives. The investigator derived a set of fifteen generalizations from the instructional objectives. This set was viewed as essential knowledge students needed for the achievement of the instructional goals. A strong, significant relationship is seen between the adequacy or completeness of the knowledge coverage during the lessons and student achievement.

The adequacy of content coverage variable is similar to one termed, student opportunity to learn the criterion material, which seeks relationships between the material covered in the class and the material on the posttest. Rosenshine (1971) reports positive, consistent, and significant relationships between measures of opportunity to learn and student achievement.

One would expect a strong relationship between the substantive aspects of instruction and student performance on tests emphasizing cognitive goals. How completely teachers deal with the knowledge component of instruction appears to be a significant aspect of teacher behavior, worthy of further investigation.

(5) "Covering the concept labels". Another adequacy of the substantive aspect of instruction variable investigated in this study reflected the extent to which teachers explicitly stated the concept labels or names implied by the instructional objectives. Experimental concept learning studies have shown that associating the critical properties and instances of concepts with the concept name or label increases the ease of subsequent concept attainment (Clark, 1971). Obviously, simply "saying" the name of the concept is not enough; the label must be associated with the essential elements of the concept. The adequacy measure in this study reflected the number of essential labels which were "spoken" by the teacher over the course of two lessons. The high correlations between the concept label coverage variable and the defining and exemplifying strategic variables would suggest that the labelling behavior occurred in conjunction with other concept-relevant moves.

INSERT TABLE 5 HERE

Each of the high inference process variables related in a positive direction to the student criterion measure. Four variables are particularly strong: accuracy of concept examples,

relevance of behavior to objectives, balance between concrete and abstract terminology, and enthusiasm/interest over the content of the lesson.

(1) Accuracy of concept examples. The knowledge presented in the Instructions for Teachers manual was utilized as a standard against which the assessment of the accuracy of teacher-given concept examples was made. Both accuracy variables are strong correlates of student gain, and are likely candidates for further study.

(2) Relevance of teacher behavior to the objectives. As with the accuracy variables, the assessment of the relevance variable implied the need for a standard against which to judge behavior. The behaviors implied by the instructional objectives in this study were essentially cognitive in nature. The observers rated teachers on the degree to which behavior was task-focused. The more directly teachers addressed the instructional objectives, the higher the relevance rating. This on-task nature of the relevance variable is reflected in the negative correlation ($r = -.57$) with actual counts of teacher off-task behavior and with the positive correlation (.91) with the low-noise, on-task behavior rating.

(3) Balance between concrete-abstract terminology. The semantic aspect of teacher behavior has been the focus of several investigations. However, it is still unclear as to which aspects of language are most influential in the instructional milieu. Lacking a theory from which to generate relevant variables, the investigator derived the concrete-abstract balance variable from

Piagetian thought. Children ages 8-12 (as in this study) are progressively able to perform formal operational thought processes; verbal language plays an important role in this progression. Concretizing reality becomes less necessary as students become able to manipulate abstractions.

The rating of the ability of the teacher to maintain a balance between concrete and abstract terminology strongly relates to student achievement. Low inference strategic correlates of the balance variable provide some insight into how teachers maintain this balance:

- teacher asks a low order question (-.02);
- asks a high order question (.37);
- repeats the same question after a student has responded (-.09);
- rephrases the question after a student has responded (.23)

(4) Expresses interest and enthusiasm over the content of the lesson. This variable attempts to capture the teacher's degree of "genuine" concern for the substance of the lesson and the extent to which the idea is conveyed to students that this is an exciting topic. In previous studies, high ratings on teacher enthusiasm strongly relate to student achievement.

Discussion

Emphasis in the last fifteen years upon viewing teaching as a form of behavior has led researchers to explore relationships between what teachers do and what students learn. The focus on actual teacher moves may have value but may also be

providing us with much too limited a picture of the critical elements operating in classrooms. Perhaps we need also to examine more closely the substantive or knowledge component of teacher behavior. All of the substantive variables employed in this study relate strongly with student gain: adequacy of concept label coverage, adequacy of concept coverage, accuracy of concept definitions, accuracy of concept examples, and relevance of the teacher's behavior to the instructional objectives. The strength of these variables suggests the need for further study.

This study merely explored relationships between particular aspects of teacher behavior and student gain. Causal relationships cannot be drawn from such research. However, one does draw a picture of the teacher behaviors related to achievement from this study. Residual gain scores are high in classes where teachers present accurate, relevant knowledge, where they give concept definitions, give concept examples, and review the main points in the lesson. This teacher is also enthusiastic and displays interest in the lesson.

The picture is of a very expository, very task-oriented teacher. And, that picture is incomplete! Although not reported here, student behaviors were also explored during this investigation. None relate significantly (at .05 or less) to the criterion measure. However, two behaviors are strong enough to warrant further study: the total frequency of student answers to teacher requests for concept definitions and examples, whether these answers are correct or incorrect ($r = .32$, $p \leq .07$);

and the student substantively challenges the teacher ($r = .31$, $p \leq .08$).

Teacher-requests for concept definitions and examples are not strong enough variables to relate significantly with achievement, although they are positive correlates. However, the greater the student practice in giving concept definitions and examples, the stronger the achievement. The student variables under discussion were defined as a function of the teacher's explicit request for definitions and examples (and strong intercorrelations substantiate these relationships).

Perhaps the frequency of student challenges is related to some aspect of class climate. In this study, challenges relates strongly with student incorrect examples (.46, $p \leq .01$) and with student requests for clarification ($r = .66$, $p \leq .001$). What is it that teachers do which allows students to know that it's "O.K." to be wrong, to challenge the teacher, and to say, "I don't understand that"? (The student incorrect concept definitions and incorrect examples-variables and the student asks for clarification-variable relate in a positive direction with student gain.)

The point here is that the student process data are important - if the full picture of the instructional system is to emerge. The study of teacher behaviors in isolation of student behaviors during instruction can only promote a distorted, unidirectional conception of teaching.

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TABLE 1

MEANS AND STANDARD DEVIATIONS OF STUDENT TEST OF UNDERSTANDING OF THE ECONOMIC CONCEPT, SPECIALIZATION
PRETEST AND POSTTEST SCORES AND CLASS MEAN RESIDUAL GAIN SCORES
(n = 22 classrooms)

CLASSROOM	PRETEST MEAN	PRETEST STANDARD DEVIATION	POSTTEST MEAN	POSTTEST STANDARD DEVIATION	RESIDUAL CLASS MEAN GAIN SCORE	STANDARD DEVIATION	NUMBER OF CHILDREN IN GROUP
5-01	25.78	4.29	30.33	4.69	+2.4757	2.13	9
3-02	24.60	3.13	27.40	5.06	+0.4213	3.68	10
4-03	28.44	3.50	29.11	4.14	-0.7365	4.00	9
3-04	25.25	2.05	23.50	3.46	-3.9638	2.54	8
3-05	23.45	2.38	24.36	3.50	-1.7603	2.45	11
5-06	27.62	4.37	29.85	5.65	+0.6172	4.2[illegible]	13
4-07	26.93	4.57	28.93	5.87	+0.2134	3.79	15
5-08	28.79	4.49	28.86	5.36	-1.2451	3.84	14
5-09	31.91	3.11	33.55	3.17	+1.1124	2.08	11
5-10	26.50	4.33	29.00	3.92	+0.6034	1.69	14
3-11	24.75	4.49	26.83	3.71	-0.2573	3.79	12
3-12	24.36	4.50	27.36	2.50	+0.5613	3.88	11
4-13	29.85	3.98	32.54	3.80	+1.6448	3.63	13
5-14	32.25	2.96	32.50	2.15	-0.1875	1.59	12
4-15	26.64	5.60	30.29	3.34	+1.7825	2.59	14
3-16	25.18	4.64	26.36	4.97	-1.0493	3.08	11
5-17	31.07	3.53	32.53	2.90	+0.7289	2.67	15
3-18	23.92	4.96	28.08	5.11	+1.6145	3.72	12
3-19	26.36	4.20	25.91	4.44	-2.3857	3.05	11
5-20	28.80	3.23	30.33	2.77	+0.2204	2.66	15
5-21	33.64	3.82	35.07	2.16	+1.3446	2.88	14
5-22	33.70	1.77	34.20	2.04	+0.4305	1.68	10

* The first numeral in the classroom code denotes grade level.

TABLE 2 FREQUENCY DATA FOR LOW-INFERENCE TEACHER PROCESS VARIABLES

(n = 22 teachers)

VARIABLE NAME	MEAN	MODE	MEDIAN	RANGE	STANDARD DEVIATION
Gives definition	2.55	2.00	2.07	11.00	2.60
Asks for definition	2.55	1.00	1.40	6.00	2.15
Total, definition giving and asking behavior	5.09	4.00	4.00	17.00	4.34
Gives positive examples	6.41	3.00	5.00	25.00	6.04
Gives negative examples	.36	0.00	.29	1.00	.49
Asks for positive examples	1.27	1.00	1.10	4.00	1.08
Asks for negatives examples	--------- Does not Occur ----------				
Total example behavior	8.05	4.00	6.50	27.00	6.74
Signals for topic shift	4.82	4.00	4.30	11.00	3.13
Reviews, Summarizes	5.18	5.00	4.83	8.00	2.34
Answers, explains	8.73	5.00	6.17	23.00	6.64
Asks low order question	41.59	24.00	37.50	75.00	19.11
Asks high order question	7.27	3.00	5.50	26.00	6.13
Repeats question	2.59	1.00	1.83	7.00	2.04
Rephrases question	4.14	3.00	3.75	9.00	2.30
Total, content shifts	13.82	7.00	12.50	18.00	5.67
Asks pairs of questions	8.09	2.00	6.50	26.00	6.57
Off-task behavior	10.96	1.00	5.50	62.00	14.85
"Other" behavior	1.50	1.00	1.28	5.00	1.26
Knowledge coverage	12.09	15.00	12.75	10.00	2.83
Label coverage	5.91	7.00	6.50	6.00	1.90

TABLE 3 ZERO ORDER CORRELATION MATRIX FOR RATED AND COUNTED TEACHER PROCESS VARIABLES

n = 32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1 Gives Definition		.67***	.83***	.72***	.45*	.29		.72***	.34	.51**	.48**	-.01	-.28	.15	.02	.06	.15	.08	.09	-.33	-.24	.34	-.20	.43*	.63***	.42*	.35*	.23	.21	.22	.35*	.32	.18
2 Asks for Definition			.37*	.43*	.16			.38*	.50**	.36*	.33*	.18	-.12	.37*	-.03	-.18	-.05	.44*	.38*	-.42*	-.27	.19	.06	.48**	.63***	.32*	.27	.25	.19	-.05	.26	.29	.29
3 Total, Definition Behavior			.61***	.67***	.25			.63***	.45*	.45*	.45*	.04	-.23	.27	.00	-.12	.06	.27	.19	-.41*	-.28	.30	-.06	.49**	.69***	.41*	.34*	.26	.22	.11	.31	.34*	.25
4 Gives Positive Concept Example				.41*	.39*			.09	.17	.07	.76***	-.25	.14	-.23	.17	-.43*	-.22	-.06	.09	-.53*	.16	.15	-.19	.56**	.67***	.60***	.60***	.50**	.52**	.55**	.66***	.61***	.36
5 Gives Negative Concept Example					.07			.05	.54**	.31	.48*	.18	.17	.06	.29	-.14	.08	.29	.25	-.29	.04	.28	.37	.18	.19	.03	.07	.10	.19	.05	.23	.19	.15
6 Asks for Positive Concept Example								.57**	.19	.32	.32	-.45*	.26	-.23	.22	-.18	.14	.13	.19	-.50*	.48*	.00	-.37	.52**	.39*	.40*	.40*	.46**	.24	.49**	.46**	.34	.31
7 Asks for Negative Concept Example																																	
8 Total, Example Behavior									.22	.67***	.78***	-.28	.18	-.24	.21	-.41*	-.17	-.01	.13	-.57**	.21	.14	-.20	.60***	.80***	.61***	.61***	.53**	.53**	.56**	.68***	.62***	.33
9 Signals Shift in Topic										.13	.35*	.02	.31	.17	.42*	-.21	.16	.69***	.09	-.49*	.09	.31	.30	.23	.15	-.07	.12	.13	.05	-.01	.05	.11	.20
10 Reviews, Summarizes the Main Ideas											.73***	.06	.20	-.38	.20	-.20	.05	-.22	.01	-.30	.20	.38	-.02	.62**	.54**	.19	.57**	.52**	.61**	.50**	.59**	.54**	-.01
11 Answers Own or Student Question, Explains												-.14	.61**	-.45*	.34	-.38	-.15	.06	.23	-.51**	.38	.22	.80***	.48*	.9***	.42*	.52**	.45*	.48*	.48*	.60**	.55**	.31
12 Asks Lower Order Question													-.15	.26	.11	.06	.20	-.08	-.04	.46*	-.25	.50**	.73***	.05	.20	-.21	-.21	-.09	-.02	-.17	-.02	-.02	-.56
13 Asks Higher Order Question														-.26	.72***	-.24	-.12	.08	.18	-.33	.65***	-.04	.26	.27	-.16	.07	.33	.40	.37	.43*	.42*	.35	.23
14 Repeats Own Question Following a Student Response															.03	.09	.12	.27	-.14	.18	-.37*	.07	.11	-.18	.06	-.18	-.25	-.18	-.09	-.31	-.29	-.18	-.08
15 Rephrases Own Question After a Student Response																-.32	.03	.11	.01	-.14	.64**	.28	.35	.29	-.07	.05	.23	.28	.23	.40	.46**	.37	-.05
16 Tells Students to Stop Irrelevant Behavior																	.63***	-.26	-.32	.34	-.21	.08	-.35	-.43*	-.30	-.49*	-.50*	-.57**	-.51	-.54**	-.62**	-.71***	-.31
17 Engages in Substantive Digression																		-.16	.26	.20	-.16	.43*	-.05	.01	.08	-.04	-.03	-.10	-.15	-.13	-.28	-.23	-.37
18 Shifts the Topic While Signalling a Shift																			.41*	-.65***	-.04	-.76***	.11	.04	.11	.02	-.02	.06	.02	-.12	-.08	.07	.12
19 Shifts the Topic After Reviewing and Signalling a Shift																				-.45*	.28	-.30	.19	.30	.30	.24	.15	.23	.18	.11	.32	.30	.25
20 Shifts the Topic While Asking a Lower Order Question																					-.37*	.26	.20	-.46*	.34	-.41*	-.43*	-.44*	-.36*	-.23	-.44*	-.45*	-.33
21 Shifts the Topic While Asking a Higher Order Question																						-.13	.07	.29	-.08	.12	.34	.40	.35	.50**	.53**	.36	.24
22 Total, Shifting Behavior																							.30	.24	.33	-.14	-.03	-.07	-.13	-.15	.07	-.07	-.18
23 Asks Two or More Questions in a Series, Without Allowing for Student Response																								.28	.06	-.14	.00	.15	.15	-.01	.17	.09	-.25
24 Covers a Greater Number of Relevant Generalizations																									.82***	.77***	.83***	.85***	.68***	.63***	.78***	.75***	.11
25 Covers a Greater Number of Relevant Concept Labels																										.71***	.65***	.66***	.55**	.42*	.60***	.61***	.33
26 Defines Concept Accurately																											.84***	.87***	.76***	.76***	.70***	.89***	.13
27 Provides Accurate Concept Examples																												.85***	.84***	.81***	.77***	.90***	.21
28 Expresses Behavior Relevant to Objectives																													.92***	.85***	.83***	.91***	.23
29 Achieves a Balance Between Concrete and Abstract Terminology																														.84***	.75***	.84***	.22
30 Uses Complete Sentences and Clear Pronoun Referents																															.83***	.86***	.19
31 Displays Interest and Enthusiasm over the Content of the Lesson																																.87***	.21
32 Displays Primarily On-Task, Low Noise Behavior																																	.21
33 Grade Level																																	

*p ≤ .05 **p ≤ .01 ***p ≤ .001

TABLE 4

PEARSON PRODUCT MOMENT CORRELATION COEFFICIENTS AND SIGNIFICANCE LEVELS FOR RELATIONSHIPS BETWEEN LOW-INFERENCE TEACHER PROCESS VARIABLES AND CLASS RESIDUAL MEAN GAIN SCORES

TEACHER PROCESS VARIABLES	CORRELATION	LEVEL OF SIGNIFICANCE
Gives concept definition	.426	.02*
Asks for concept definition	.190	
Total, definition behavior	.349	.05*
Gives positive concept examples	.497	.009**
Gives negative concept examples	.225	
Asks for positive concept examples	.177	
Asks for negative concept examples	--Does not occur--	
Total, example behavior	.491	.01**
Signals a topic change	-.008	
Reviews, summarizes main ideas	.376	.04*
Asks lower order questions	-.098	
Asks higher order questions	-.047	
Repeats own question after student response	-.309	.08
Rephrases question after student response	-.257	
Signals and changes the topic simultaneously	-.171	
Uses review-signal-shift pattern	.122	
Changes topic with a low order question	-.301	.08
Changes topic with a high order question	.162	
Total number of shifts in the topic	.165	
Asks pairs of questions	-.013	
Tells students to stop irrelevant behavior	-.050	
Other, including substantive digressions	-.043	
Content covered	.456	.01**
Concept labels covered	.528	.006**

*p < .05 **p < .01 ***p ≤ .001

TABLE 5

PEARSON PRODUCT MOMENT CORRELATION COEFFICIENTS AND SIGNIFICANCE LEVELS FOR RELATIONSHIPS BETWEEN HIGH INFERENCE TEACHER PROCESS VARIABLES AND CLASS RESIDUAL MEAN GAIN SCORES

TEACHER PROCESS VARIABLES	CORRELATION	LEVEL OF SIGNIFICANCE
Accuracy of concept definitions	.326	.06
Accuracy of concept examples	.376	.04*
Relevance of behavior to objectives	.370	.04*
Balance between concrete and abstract terminology	.381	.04*
Uses complete sentences and correct pronouns	.274	
Expresses interest and enthusiasm over content of lesson	.478	.01**
On task, low noise behavior	.279	

*$p \leq .05$

**$p \leq .01$

APPENDIX

DEFINITION OF VARIABLES

Definitions of Teacher Process Variables

Substantive, semantic, and strategic components of instruction serve as major categories for the generation of the teacher process variables. Specific variables in each of these three categories were derived essentially from previous research in instructional processes or in teacher effectiveness. Following are the definitions employed for each of the components and their variables.

Substantive Variables

The substantive aspect of an instructional event referred to the body of knowledge made explicitly available to students during the lesson. Five variables were designed to assess the accuracy, adequacy, and relevance of the teacher's substantive presentation:

(1) The teacher provides accurate concept definitions. A concept definition was defined as a statement linking a concept label or name with at least one of the concept's attributes. Accuracy of a definition was defined as the degree of congruence of the teacher's statement with a given body of established and recognized knowledge. For this study, that body of knowledge was the information made available to teachers in the Instruction to Teachers Manual.

(2) The teacher provides accurate examples and non-examples of the concept. A concept example illustrates an aspect or an

essential attribute of the concept; a non-example illustrates the absence of a relevant concept dimension. Accuracy of examples/non-examples was defined as the degree of congruence of stated instances with those implied by the knowledge contained in the Instructions to Teachers Manual.

Both of the accuracy variables were high-inference, subjective ratings, scored by a trained observer on a one-to-seven scale, with a score of seven representing outstanding performance.

(3) The teacher explicitly states relevant knowledge components as implied by the instructional objectives. Adequacy or completeness of content coverage was defined as the number of substantive generalizations, as implied by the instructional objectives, which were explicitly included by the teacher in the course of two concept lessons. A basic set of knowledge components, implied by the instructional objectives, was identified and listed for the trained observers. A tally was made for each component as the observer recognized the obvious inclusion of each generalization in the taped lessons. This variable represented the number of generalizations, out of fifteen possible, which were actually included in the lessons.

(4) The teacher explicitly states the concept labels, or names, as implied by the instructional objectives. Adequacy or completeness of concept-label coverage was defined as the number of concept labels (or names, terms, words) as implied by the instructional objectives, which were explicitly spoken by the teacher in the course of two concept lessons. Nine

concept labels were implied for instructional usage. A tally was made for each concept label as the observer heard the word or phrase actually spoken by the teacher. This variable represented the number of concept labels, out of nine possible, which were actually spoken by the teacher.

(5) The teacher's behavior relates directly to the achievement of the instructional objectives. The relevance of teacher behavior to the achievement of the lesson's objectives was assessed as the degree of congruity between the teacher's verbal utterances and the knowledge and processes implied by the objectives. This was essentially an "on-task" variable, measuring the degree of task orientation inferred by the observer. The relevance variable was rated on a one-to-seven scale, with seven representing a very high degree of congruity between the teacher's utterances and the knowledge implied by the instructional objectives.

Semantic Variables

The semantic aspect of an instructional event referred to the teacher's ability to convey meaning through appropriate choices of terminology. Three semantic variables were utilized for this investigation. Each of the three variables was viewed as a high-inference variable, with the observer rating the teacher's performance on a one-to-seven scale in each case.

(1) The teacher employs a balance of concrete and abstract terminology. Concrete words or concepts such as factory and assembly line refer directly to tangible, specific, particular

phenomena which may be directly perceived by the senses. Abstract words such as justice, communism, truth, refer to generalized attributes or qualities of thought which exist apart from any particular object. Maintaining instruction at a concrete conceptual level allows little opportunity for students to develop new, abstract, and often highly usable concepts. The introduction of concept definitions and examples facilitates comprehension of abstract conceptual terms. The concrete-abstract balance variable was rated as poor if either type of imbalance occurred: solely concrete terminology or an abundance of abstract and undefined terminology.

(2) The teacher speaks in complete, rather than incomplete, choppy sentences. A complete sentence was defined as a statement containing at least a subject and a verb which logically were connected to create a meaningful idea. A choppy sentence was defined as a statement whose initial subject was replaced by the introduction of a new subject before the first thought was completed. In such cases, the first topic would be left "dangling".

(3) The teacher uses pronouns which clearly refer to their antecedents. "Floating words" are minimal. The referent for a word is seldom in doubt. This variable refers to the misuse of pronouns, such as they, it, this, them.

Strategic Variables

Instructional strategy referred to the total set of verbal operations, or movements, performed by the teacher during the

course of a lesson to achieve the instructional objectives. For this investigation, a teacher's purposive moves were counted. A purposive move referred to an activity performed by the teacher which had the function or effect of progressing the lesson from one substantive or process point to another point. The purposive move was distinguished from an utterance. An utterance was a verbal expression, performed by one person at a given time. An utterance may contain a single purposive move or may contain several purposive moves.

The strategy variables were defined as low-inference variables. The frequency of occurrence of each variable was computed for each lesson and averaged over the two lessons to provide a score for each teacher for each variable. The following were the strategy variables examined in this investigation:

(1) The teacher gives a concept definition. (2) The teacher asks students to give a concept definition. A definition is a statement of meaning given by the teacher which contains the concept name and at least one relevant attribute of the concept under discussion. A request for a concept definition is a teacher question which explicitly asks students to provide the statement of meaning which includes at least one relevant attribute for the concept under discussion.

(3) The teacher gives a positive or negative concept example. (4) The teacher asks students to give a positive or negative concept example. A positive concept example is an instance of the concept which illustrates at least one relevant

dimension of the concept. A negative concept example illustrates the absence of relevant concept dimensions. The teacher gives a positive or negative concept example when she explicitly refers to the stated instance as an illustration or counter-illustration of the concept. The teacher asks the students to provide a positive or negative concept instance when she explicitly requests a concept illustration response which has not been previously included in the lesson.

(5) The teacher reviews, summarizes the main ideas in the lesson. A review or summarization is the restatement or paraphrasing of ideas which have already been expressed in some form in the lesson. Reviewing behavior may occur within lessons, at the close of a lesson, or at the beginning of the second lesson. The teacher may choose to utilize the same terminology and level of thinking as has been expressed in the lesson to that point, or the teacher may attempt to summarize at a more abstract level. In either case, this type of purposive move was coded as reviewing behavior.

(6) The teacher changes or shifts the topic of the lesson. A content shift was defined as the introduction, through statement or question, of a topic or main idea different from that which was the subject of the last recorded purposive move.

(6a) The teacher signals a shift in the topic. Signalling a shift in the topic was defined as an overt cueing to students that the content of the lesson was about to change. The teacher employed a phrase, term, or statement which served to redirect the attention of students. For example: "We've been talking

about occupational specialization. Now, let's change the focus, and look at geographical specialization."

(6b) The teacher employs a summary-signal-shift pattern. The summary-signal-shift pattern variable was defined as the percentage of total teacher content shifts which were executed as a part of a summary-signal-shift pattern of purposive moves. The frequency of occurrence of each of the ratio components was averaged across two lessons; the ratio score was then computed. An example of summary-signal-shift dialogue might be: "We've been talking about occupational specialization. We said that people focus on particular aspects of production in order to maximize their skills, interests, and life goals. We also saw that, in general, we are able to produce more goods and services when people specialize." (Summary) "Now, let's change the focus" (signal) "and look at geographical specialization" (shift to new topic).

(6c) The teacher shifts the topic while asking a low order question. The shifting of the content while asking a low order question was defined as the percentage of total content shifts which occurred simultaneously with the asking of a low order question.

(6d) The teacher shifts the topic while asking a high order question. The shifting of the content while asking a higher order question variable was defined as the percentage of total content shifts which occurred simultaneously with the asking of a higher order question.

(7) The teacher asks a low order question. A low order

question calls upon students to engage in recall or translation as cognitive processes. The teacher asks a low order question when calling upon students to recall a specific event, object, idea, or to translate or describe a given stimulus. To recall is to remember a particular bit of knowledge. To translate is to describe particular elements of a given stimulus. Examples: Recall - What is the name of the river in our town? Translation - What do you see in this picture?

Teacher questions asking students explicitly for concept definitions or for a concept example or non-example were coded in those categories, not as low or high order questions.

(8) The teacher asks a high order question. A high order question calls upon students to engage in cognitive processes of comparison/contrast, analysis, application, or evaluation. A teacher's question is coded in this category if the question calls upon students to compare or contrast two or more objects, events, qualities, in terms of similarities or differences; or or to analyze a phenomenon by exploring component elements, underlying principles, or relationships; or to apply or relate a concept to a new situation; or to evaluate with criteria a given situation, event, object.

(9) The teacher asks a pair of questions in a series, not allowing for student response. Questions in a series were defined as two or more high or low order questions which occurred within the same teacher utterance, allowing no time for student response. Pairs of questions which occurred in a series were counted within each lesson, and averaged across the two lessons

to provide the value for this variable.

(10) The teacher answers her own or a student's question by explaining. This variable occurred as the teacher responded, offering an explanation, providing a generalization, or otherwise answering a question or statement of student misunderstanding. This category is definitely a response category. Its occurrence follows either: (a) a question asked by the teacher and incorrectly responded to by students, or (b) a question or statement of misunderstanding or challenge posed by a student.

(11) The teacher repeats her own question, following a student's response. This variable was defined as the teacher's restatement of a previously asked question, using essentially the same terminology as in the first occurrence of the question. The first and second occurrences of the question-asking had to follow in close time proximity to each other. This category could only be coded following at least one student response to the original teacher question. The instance of a teacher's repeated request for more information to a translation question, such as "What do you see in this picture?", was excluded from this category.

(12) The teacher rephrases her own question following a student's response. This variable was defined as the teacher's restatement of a previously asked question, changing the basic terminology employed in the first asking of the question, while maintaining the essential meaning of the question. Rephrasing could only occur after at least one student had responded to the first asking of the teacher's question.

(13) The teacher tells students to stop irrelevant behavior. Task irrelevant behavior was defined as any utterance which served a purpose not directly related to the development of the instructional objectives and which was concerned in general with student irrelevant behavior or with classroom organizational matters. Utterances such as: "Stop playing with your pencil." "We'll have recess in fifteen minutes." or "Close the door," were coded in this category.

(14) The teacher engages in substantive digression. Other behavior was defined as any teacher utterance which was a substantive digression from the content implied by the instructional objectives. For example, the teacher may relate a story about her efforts to buy a new car.

Two additional strategic behaviors were defined as high inference variables:

(1) The teacher expresses enthusiasm and interest in the content of the lesson. A high rating on this variable indicates that the teacher seems to convey a sense of genuine interest, curiosity, and excitement about the content of the lesson. This enthusiasm is conveyed through voice inflection, apparent spontaneity of student-teacher interaction, and through the giving of more or less explicit verbal clues which connote teacher interest.

(2) The teacher displays an on-task approach toward the classroom atmosphere and its interactions. A high rating on this variable indicates that the teacher appears to promote a constructive, business-like atmosphere, while encouraging a

healthy flow of student-teacher interactions. The teacher is apparently in control of the learning situation.

Definitions of Student Process Variables

Select student behaviors occurring during instruction were measured by means of a low inference counting procedure. Two major types of student behaviors were examined: (1) responses to teacher questions, and (2) initiating comments. The variables were as follows.

Four types of student responses to the teacher's low or high order questions were examined in terms of the correctness/ incorrectness of the response.

(1) The student correctly answers the teacher's low or high order question. A correct response was one which was logical and substantively sound. The answer must also be in direct response to the teacher's question, and must be accepted by the teacher as correct.

(2) The student incorrectly answers the teacher's low or high order question. An incorrect response was one assessed as logically and substantively incorrect by the coders. The response may or may not have been accepted as correct by the teacher. The body of information against which the responses were compared was that included in the Instructions for Teachers Manual.

(3) The student responds to the teacher's low or high order question with a logical answer. A logical response was a substantively "reasonable" statement which was congruent with

the general framework of the lesson. However, the response was not directly related to the teacher's immediate question. The teacher may or may not have accepted the response as correct.

(4) The student responds to the teacher's low or high order question with a true-but answer. This response was a logical, substantively correct answer which was directly related to the teacher's immediate question. However, in this case, the teacher overtly rejects the response.

Four additional variables indicated the student's response to teacher requests for concept definitions and for concept examples.

(5) The student provides a correct concept definition.

(6) The student provides an incorrect concept definition. A concept definition is a statement of meaning which includes at least one relevant attribute for the concept under discussion. A teacher-request for a concept definition must precede the student's response. The correctness or incorrectness of the student's definition was assessed by the coder. The body of knowledge against which the responses were compared was that included in the Instructions to Teachers Manual.

(7) The student provides a correct concept example.

(8) The student provides an incorrect concept example. A correct concept example is an instance of the concept which illustrates at least one relevant dimension of the concept. A teacher-request for a concept example must precede the student's response. The correctness or incorrectness of the concept examples was assessed by the coder. The body of knowledge

against which the responses were compared was that included in the Instructions for Teachers Manual.

Four student initiating behaviors were examined also.

(9) The student expresses misunderstanding, requests clarification or repetition. For a student utterance to be coded in this category, it must be one of the following types of verbal expressions: (a) the student asks a question, requesting clarification, repetition, or interpretation of what the teacher has asked or stated. For example, "Would you say that again?" (b) The student overtly expresses a lack of understanding. For example, "I don't understand that!" or "What do you mean?"

(10) The student substantively challenges the teacher. To be coded in this category, a student's self-initiated statement must contain an overt reference to a knowledge-related issue. The student may challenge the teacher if the teacher is misrepresenting some bit of information or if the student has a misconception which is threatened by the teacher's comment. There may, also, be a gap in the logical progression of information in a lesson. In this case, a student may raise a substantive question which exposes the missing information.

(11) The student offers irrelevant and off-task talk. Talk-irrelevant behavior was defined as any utterance which served a purpose not directly related to the development of the lesson and which was concerned with personal and/or organizational matters. Student comments such as: "When is recess?" or "It's cold in here" were coded in this category.

(12) The student makes a contribution only tangentially related to the lesson. This Other category includes (a) student substantive digressions, usually of a story-telling nature, which were tangentially related to the lesson and (b) any verbal student-initiated behavior which did not belong in another category.